

## **Analysis of Mixed Hardwood Chipping Operations and Chip Quality for Bioenergy**

John Vance<sup>1</sup>, Jingxin Wang<sup>1</sup>, Shawn Grushecky<sup>1</sup>, Joseph Moritz<sup>2</sup>, Raffaele Spinelli<sup>3</sup>

### **Abstract**

A mechanized harvesting system combined with whole-tree chipper producing mixed hardwood chips was investigated on two sites in eastern Ohio in 2016. The harvesting system observed included a Timbco 425 feller-buncher, two grapple skidders, Morbark 27RXL whole-tree chipper, and three semi-truck with chip-van trailers. Production and machine rate data were collected through time-motion study, with chipping time elements categorized into feeding, chipping, and loading. A chipping cycle averaged 27 minutes with a production of 23.54 green tons, which provides an hourly rate of 52.3 green tons per productive machine hour. Trucking transportation distance was 76 and 97 miles roundtrip, respectively for the two harvest sites, trucking cycles ranged from 106 to 220 minutes with an average of 162 minutes per round trip. Chipping production and cost estimation models will be derived from this study, and they will be useful to biomass harvesting and utilization in the region. Chip samples were taken from the operation to evaluate the properties and characteristics for use as an energy feedstock. Our results showed that the chips had 37% moisture content (wet basis), 0.212 g/mL bulk density, and 10.53% bark content. Four sieves were used to separate the chips into length classes. Size distribution of chips were found to be 4.52% oversize (> 63mm), 3.12% large (46-63mm), 45.37 % medium (16-45mm), 46.34 % small (3-15mm), and 0.65 % fines (< 3mm). Further analyses were conducted for the original samples containing bark as well as debarked samples from the bark content test to investigate any advantages of debarking. Heating value was found to be higher for the debarked sample 8,019.70 Btu/lb compared to the sample with bark 8,002.36 Btu/lb while the ash content was found to be lower 0.31 % debarked compared to 0.68 % with bark.

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<sup>1</sup> West Virginia University, Division of Forestry and Natural Resources, PO Box 6125, Morgantown, WV 26506, [jxwang@wvu.edu](mailto:jxwang@wvu.edu)

<sup>2</sup> West Virginia University, Department of Animal and Nutritional Sciences, Morgantown, WV 26506

<sup>3</sup> CNR Ivalsa, Via Madonna del Piano 10, 50019 Sesto Fiorentino (FI), Italy